Lessons from the VLA Long Wavelength Sky Survey (VLSS)

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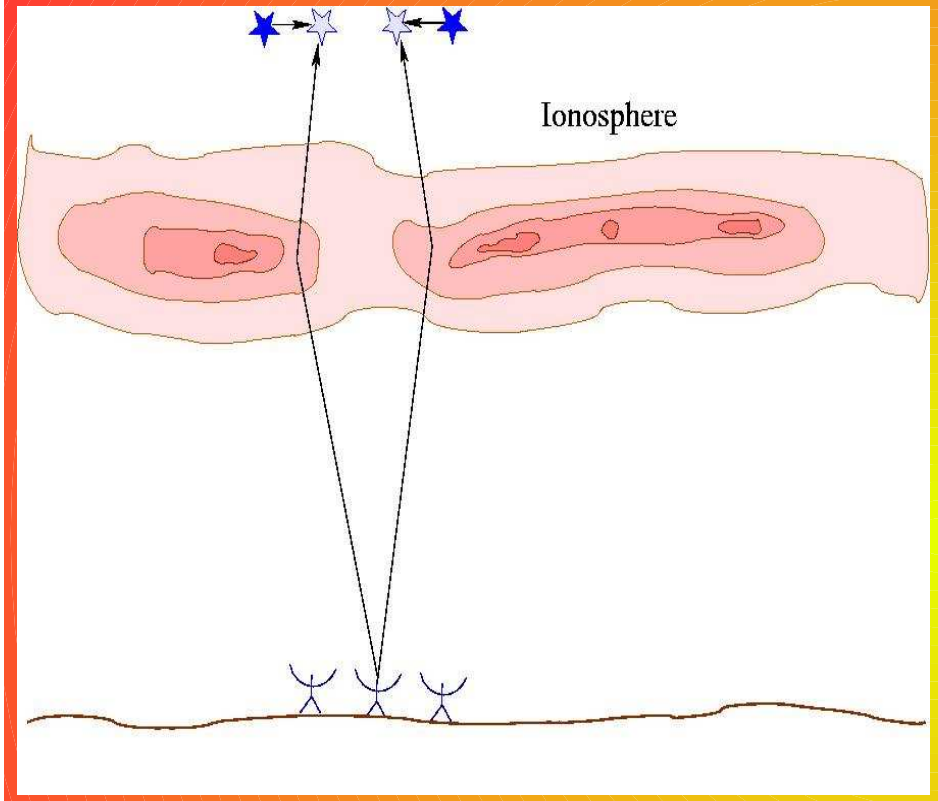
- VLSS is currently being carried out at 74 Mhz with the VLA in B configuration.
- Calibration techniques developed at cm wavelengths are inadequate at m.
- New calibration technique developed for modest baseline lengths.
- Longer baselines/ λ need better calibration.

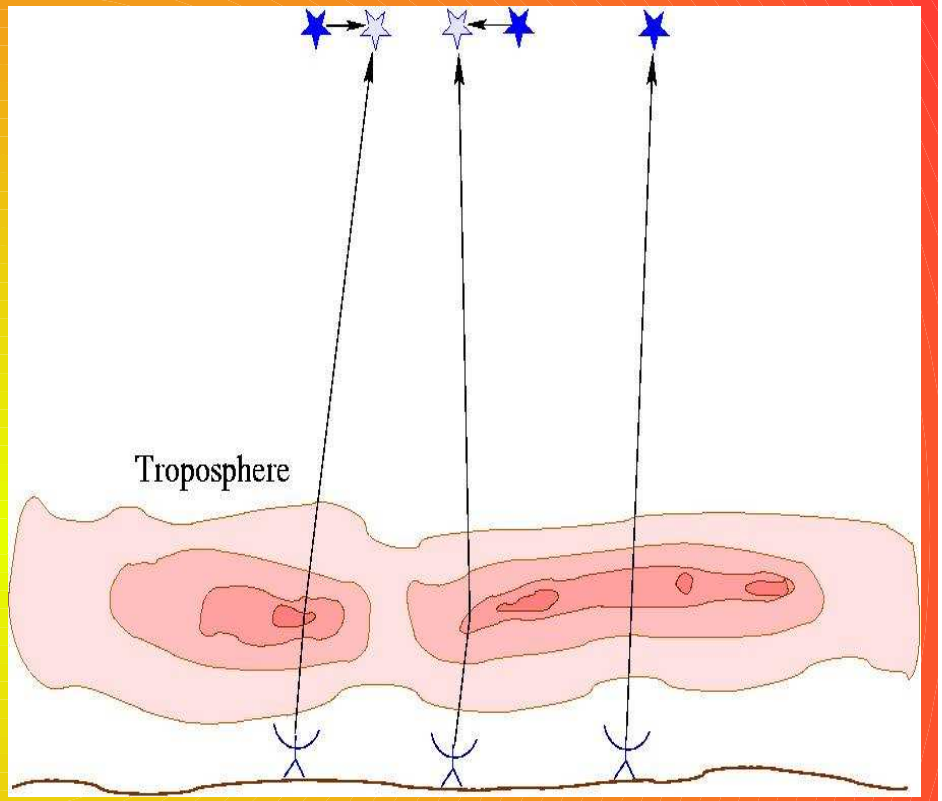
Lesson 1: Calibrate your instrument

- Instrumental phase calibration distinct from atmospheric calibration
- Inst. phase constant across beam, atm. Not.
- VLSS needed to model atmospheric phase and average over non modeled phase errors
- Calibrated instrument can (sometimes) image sky

Lesson 2: Understand (model) the ionosphere

- Antenna primary beam at long λ very large.
- Ionospheric phase varies across the antenna beam.
- Self cal works iff small source dominates FOV
- Weak sources or wide field imaging requires spatially variable calibration.





Cartoons showing the difference between the ionospheric (common phase screen) and tropospheric (separate phase screens) phase effects.

- VLSS Calibration scheme (10 km):
  - Calibrate instrumental phases
  - Image sky in snapshots
  - Geometry distorted but (usually) not source
  - Estimate 2D phase screen using offsets of known strong sources
  - Correct distortion in imaging and deconvolution
  - “Field based calibration” calibrates ionosphere – not the telescopes

- Limitations of Field Based Calibration
  - Works when phase from a given source is a linear gradient across the array.
  - Sources are shifted but not distorted.
  - High order phase errors across the array will defocus the image.
  - Calibration done in the image plane – doesn't work if sources are defocused.

- Larger Arrays and Longer Wavelengths
  - High order phase terms across array become important.
  - High order phase terms defocus the image.
  - Correction requires a higher order model determined in uv plane.
  - Need either a 3D ionospheric model or 2D phase screen for each antenna.